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A solution for the “dark matter mystery” based on Euclidean relativity

The study of this article suggests an explanation for the “dark matter mystery”. This explanation is based on a modification of Newton’s law. This modification is conducted from an Euclidean vision of relativity. Concerning the mystery of the velocity of the stars inside a galaxy, the study calculates a theoretical curve which is different from the one coming from Newton’s law. This theoretical curve is very close to the measured one. Concerning the mystery of the velocity of a galaxy inside its group, the explanation is more direct. For this mystery, the study calculates a greater value for G , the gravitational constant.

1. INTRODUCTION

The theoretical aim of this article is to address an issue yielded by general relativity. This issue may be explained by: “global space’s shape determination”. This absolute space-time is the general relativity space-time, and this space deformation in space-time must be in conformity with Newton’s law at least for long distances.

The adopted point of view is an Euclidean relativity. An Euclidean mathematical context is used, with 4 dimensions (three of space, x , y , z , and one of time: ct). This for restricted relativity. For general relativity of course we use the same and we extend it overall with a tensor. Except that here locally it is an *Euclidean* metric used to represent space-time.

Within this mathematical framework the physics principles are exactly those of relativity: isotropy of space, inertial frames of reference with reciprocities between those inertial frames, constancy of the speed of light in each inertial frames, moving from restricted relativity to general relativity by covariance along the geodetic trajectories of the inertial frames, etc... This for the restricted version, and of course for the general one: deformation of space-time by energy, expression of a force (gravitational ...) by a space-time deformation.

There exists however a difference in the physics principles, between relativity and our approach. Indeed, here constancy of space-time distance is not an aim, in a global representation of space-time. In other words, we do not use Minkowski’s representation since we wish to remain in Euclidean representation. Hence, the basic principle of an invariant space-time length when changing inertial frames is left off.

The method used consists to postulate first that Lorentz’s equations are simply a consequence of a space-time deformations by energy. In other words we try to express the general relativity “deformation” principle, in the context of restricted relativity.

Once this done, physics inconsistencies are found. Of course we try to elude them. This leads to finally postulate the existence of indivisible particles, from which matter is made of. Back to our first postulate, we find a space time determination, coherent with Lorentz’s equations. This will be our final determination of the shape of global space inside space-time.

2. RETRIEVING LORENTZ'S EQUATIONS

Lorentz's physics context is used. Let us point it out. There are two inertial frames, $R(O, x, y, z, ct)$ and $R'(O', x', y', z', ct')$, in uniform rectilinear motions at the v speed one compared to another, along Ox axis. X is increasing along Ox axis, and x' is decreasing along $O'x'$ axis. In this case, only x, ct , and x', ct' dimensions are important. At $t = x = 0$ there is also $t' = x' = 0$.

In order to find Lorentz's equations within this physics framework, and since our representations are Euclidean, it is necessary to suppose that $O'x'$ axis rocked with an α angle compared to Ox axis, with $\sin(\alpha) = v/c$. See figure 1. In the same way it is necessary to have O' coordinates equal to: ($x = vt$, and $ct = v^2 t/c$).

Conversely under these conditions the reader will be able to calculate that Lorentz's equations are found. See figure 1. But for retrieving Lorentz transform a strange mechanism must be followed here. The projection of the space-time events must be done as being parallel to Ox and Ox' axis when calculating their R' coordinates. Of course the usual mathematic rule is to use those projections parallel to Ox' and Ox axis. In the usual Minkowski's representation there is no such issue. In fact this Euclidean representation is not mandatory here.

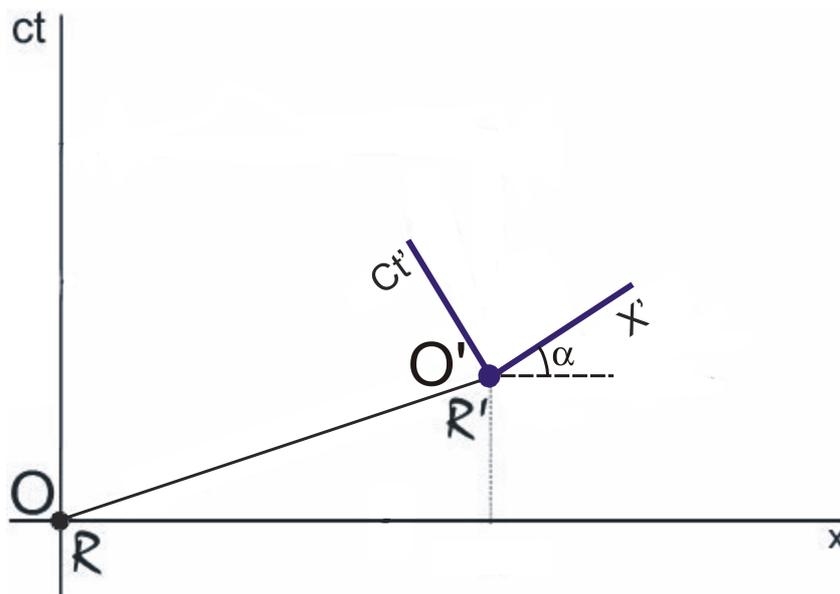


Figure 1: Lorentz's equations in the context of Euclidean relativity.

On the basis of this Euclidean model of restricted relativity, we are tempted to suppose a coherent physics postulate. This postulate is the following.

POSTULATE 1

<< Any particle with a non null mass m , moving with v speed along Ox axis, x increasing, compared to an inertial frame $R(O, x, y, z, ct)$, deforms space-time around it with a rotation of the $OxOx'$ plan around the $OyOz$ axis, with an α angle between Ox and Ox' , such as $\sin(\alpha) = v/c$.

During the displacement of this particle from O to $A(x = vt, ct)$, a vacuum appeared inside space-time. The location of this vacuum is the (O, O', H) triangle, such as: O' coordinates are $O'(vt, v^2 t/c)$, H coordinates are $H(vt, 0)$.

In the borderline case of a photon, with $v = c$, the swing becomes maximum: $\alpha = \pi/2$, and the vacuum is the (O, A, H) triangle.

Figure 2 below represents the effect of postulate 1. A P particle is moving at v speed in the inertial reference frame R , parallel to Ox axis, and in the direction of x increasing. At the t instant, the particle is located coordinates x and ct in R (A point). The inertial frame R' centered on O' "is attached" to the particle. Hence R' is also moving uniformly along Ox axis.

It is the same case as the one of figure 1, except that here exists the P particle on A point. On figure 2, the space line rocked with the α angle, locally in A.

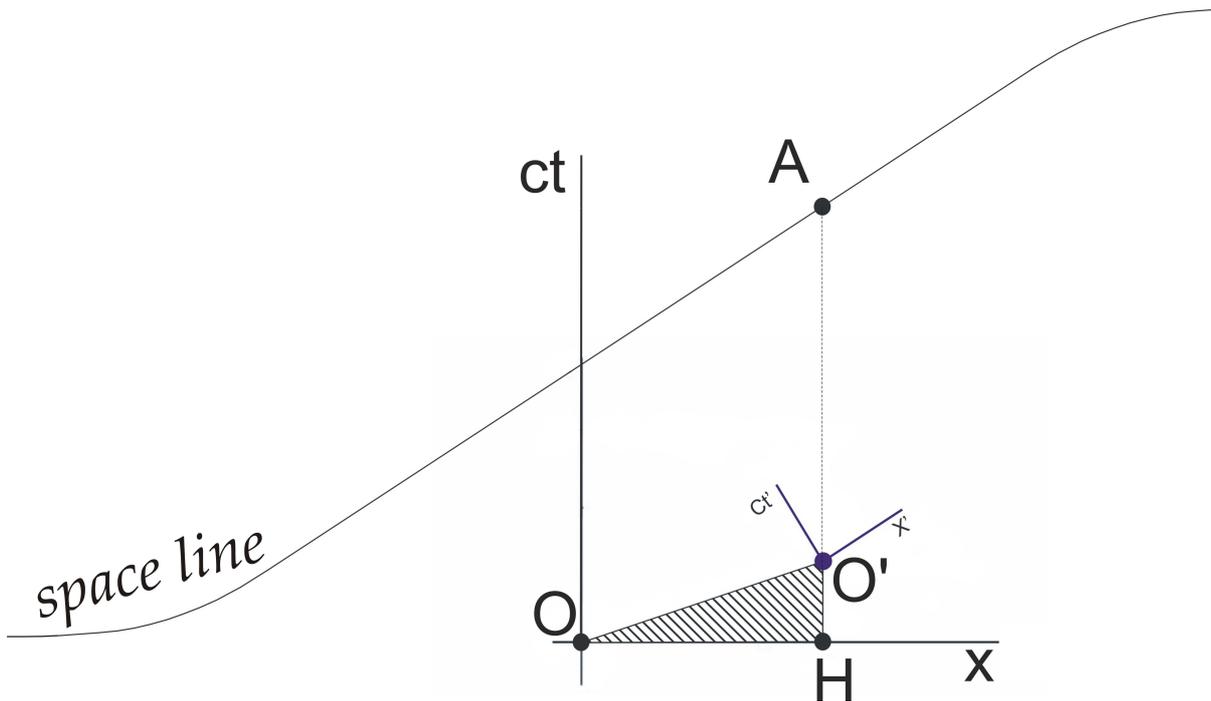


Figure 2: Postulate 1.

On the other hand, far from A point this line of space has become parallel to Ox axis. This is indeed the only realistic possibility ! It is difficult to imagine the movement of a particle deforming the entire universe this way along Ox axis.

With this postulate, the equations of Lorentz now express a local deformation of space-time, caused by the energy of the moving particle (postulate 1 above). This respect of Lorentz's equations is only *local* to the particle. In other words this respect is done only for *low values* of x' and ct' (and also for R' such as O' is close to A at the t instant).

Those restrictions explain the Sagnac effect in a very simple manner. Let's remind that this effect has been proven to be valid in case of inertial reference frames [1]. Therefore, relativity is not able to explain it in a coherent manner.

In case of the Sagnac effect experiments, of course, between the mirrors or inside optic fibers, light is not travelling close to the disk or any rotating matter attached to the disk. Even the optic fibers are always quite far away from the light beam itself. In this case, the model prediction is simple Galilean equations, not Lorentz transform. As a direct result, the Sagnac effect is explained in a very coherent manner. Indeed, $x = (c-v)t_1$ and $x = (c+v)t_2$ implies $\Delta t = t_1 - t_2 \cong 2xv/c^2$ which is the Sagnac effect experimental measurement in the laboratory frame. In case of those Galilean equations, the moving frame (the frame which is attached to the moving light beam emitter and receiver) doesn't give any further information. The speed of light is not constant in that frame but obeys classical superposition rules, as shown by experimental result.

On the contrary, for example in the case of atomic clocks, there is matter close to the measuring atom, which is the atom itself! Therefore in this case, the model prediction is usual Lorentz transform. Hence the result here is relativistic time dilatation as shown by experimental data.

It will be noticed that this "re-discovery" of Lorentz's equations works thanks to the positioning of O' (thus the positioning of A) indicated previously: $(vt, v^2t/c)$ for O' . It is known that this position of O' explains, noticeably, the asymmetry of the twin paradox in relativity. This position corresponds to a real "vacuum" which appears inside space-time. In addition it works thanks to the space-time swing indicated in the postulate above. This swing modifies with the $\cos(\alpha)$ ratio, equal to $\sqrt{1 - \sin^2\alpha} = \sqrt{1 - v^2/c^2}$, each temporal values (in ct) and space (in x). However this swing is only local, not global.

Restricted relativity is retrieved with the help of a simple deformation of space in space-time.

3. LUMINOUS POINTS

However at this stage a problem of coherence arises since a particle is constituted of smaller particles. Indeed, how to ensure that space-time deformation generated by the movement of a big particle, composed by a heap of smaller particles, can rise from the deformations of these smaller particles ?

To ensure this coherence a solution consists in supposing that matter is made up of a restricted group of very small “indivisible” particles. These small particles must be conceived in such a way that they can explain space-time deformations generated by any other composed particle. For this explanation a simple operation must calculate the final deformation generated by the large particle, from the small particles it is made of.

Thus defined, this operation must allow, by construction, calculation of the shape of absolute curves of space, starting from the positions and energies of these “small indivisible particles”. At the same time, this operation must be, of course, compliant with postulate 1 and Lorentz’s equations.

From there the second postulate arises, which follows.

POSTULATE 2

<< Each particle consists of a certain number of smaller particles, called the “luminous points”. These “luminous points” are moving constantly at the c speed, inside the first particle, and with respect to any inertial frame of reference >>.

From this postulate, it is possible to determine in a single way any deformation generated by any particle. For that, we apply postulate 1 to these “luminous point” particles. For these luminous points the α angle is equal to its limit value $\pi/2$. The shape of space is thus at any time the result of successive combinations of these small deformations caused by all these “luminous points”.

What remains to be specified is the way of combining those various deformations. This will be specified by the postulate 3 which follows. After that, it will be possible to check that the α angle calculated starting from postulates 2 and 3 is well given by the formula of postulate 1.

For that let us return to Lorentz’s equations. A first mathematical observation is essential. The conservation equation of the energy of restricted relativity is found by quantifying the luminous point trajectories lengths, inside P particle. It is what we will see.

The particle attached to the O' point is modelled as consisting of only one luminous point. Consequently the obtained model is the one described by figure 3. It can be check that the reasoning remains valid in the general case of a particle made up of several luminous points.

When the P particle moves from O point (on the figure) to A point, along OA segment, the luminous point contained follows a trajectory having a << V >> shape, that is.:

- a) First stage: displacement at the speed $+c$ along Ox, (milked in fat on the figure).
- b) Second stage: displacement at the speed $-c$ along Ox (milked in fat on the figure).

For the first stage, L1 is the displacement length, and L2 (positive) is the displacement length of the second stage. If x is the position of the A point, we can write: $x = vt = L1 - L2$. This x position is also the coordinate of P in R at this time t . Indeed at t , in R, the position of P coincides with A point.

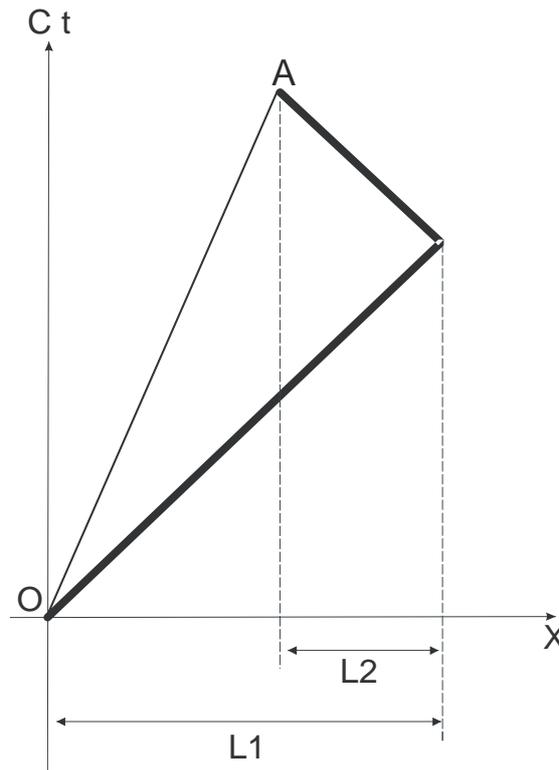


Figure 3: Luminous point trajectory in a moving particle.

Hence:

$$ct = L1 + L2 \qquad vt = L1 - L2 \qquad (1)$$

In addition we can write:

$$\frac{(L1 + L2)^2}{2} = \frac{(L1 - L2)^2}{2} + 2L1L2 \qquad (2)$$

This last equation is nothing more than relativistic equation of energy:

$$E^2 = E_{mvt}^2 + E_m^2$$

with $E = mc^2/\sqrt{1 - v^2/c^2}$, $E_{mvt} = mvc/\sqrt{1 - v^2/c^2}$, and $E_m = mc^2$.

To obtain the equivalent equation for the energy densities, each term of this equation is divided by the value $(L1 + L2)^2/2$ which is the value of the total energy of the particle:

$$1 = \frac{(L1 - L2)^2}{(L1 + L2)^2} + \text{oper}(L1, L2)^2 \qquad (3)$$

With:

$$\text{oper}(L1, L2) = \frac{2\sqrt{L1L2}}{L1 + L2}$$

The introduced operator is the relationship between the algebraic average and the arithmetic mean.

It is equal to the relativistic coefficient $\sqrt{1 - v^2/c^2}$.

Indeed, from (1): $2L1/ct = 1 + v/c$, and $2L2/ct = 1 - v/c$, and then $\sqrt{1 - v^2/c^2} = 2\sqrt{L1L2} / (L1 + L2)$.

Let us remind that equation (3) is also written: $1 = \sin^2(\alpha) + \cos^2(\alpha)$ where α is the angle of the space-time swing of postulate 1.

Finally, this last study of Lorentz's equations led us to retain an operator.

We will use this operator to postulate, finally, the mode of determination of general relativity absolute space-time. By construction, this determination will be compatible with restricted relativity.

4. RELATIVISTIC OPERATOR

This is done by the following postulate which follows. It only generalizes the previous observation done about Lorentz's equations.

POSTULATE 3

<< *Space shape in space-time is given at any point by the ratio of the infinitesimal space lengths, ds along space line, and dx its length projected on Ox axis. This ratio is equal at any point to the relativistic operator applied to the two following values:*

- a) $L1$: sum of the heights of vacuum of space-time deformations propagated in Ox direction, x increasing,
 - b) $L2$: sum of the heights of vacuum of space-time deformations propagated in Ox direction, x decreasing
- >>

That is to say:

$$\frac{dx}{ds} = \frac{2\sqrt{L1 L2}}{L1 + L2}$$

Where $L1$ and $L2$ are the 2 above-mentioned sums.

This operator is neither linear nor associative. But this doesn't matter since it is calculated once, at any point of space.

But it must be checked that this operator yields the same result when calculated in different inertial frames. That is to say that, for postulate 3, the choice of the inertial frame has no incidence on the final calculated space's slope.

In fact this is the case because of the Lorentz's equations properties, and also because this operator's value is equal to $\sqrt{1 - v^2/c^2}$. However, this can be also proven by direct calculation. This is done on appendix 5.

It is written above that $L1$ and $L2$ are the sums of the heights of vacuum of the "propagated deformations". It is necessary to describe how these "space-time deformations" are propagated.

The mechanism is very similar to waves propagated by the movement of a boat over a water surface. Let us consider figure 1. The initial deformation relates to the $OxOct$ plan.

The propagations of this deformation in space-time are carried out on remaining space dimensions, i.e. Oy and Oz , more generally on any Or direction, half-line based on O and contained in the Oyz plan.

The form of these *propagated* deformations is each time exactly the same as the *initial* deformation. The initial deformation was done on $OxOct$ plan (space-time swing represented figure 1). Now the propagated deformation is the same but it relates to the $OrOct$ plan in place of $OxOct$ plan.

The height of this propagated deformation attenuates progressively as r increases. The attenuation law, g , will be given further. At any time, the "luminous point" thus emits this deformation. Therefore, like in the case of the boat, the finally overall propagated deformation is the envelope of all these propagations of deformation. (In the case of a boat this envelope has a << V >> shape which is the final shape of these waves over the water surface).

Above, the initial space-time deformation is connected to the existence of a "space-time vacuum". What does become this vacuum during the propagation of this deformation ? It is propagated too. It relates to 3 dimensions y , z , and ct .

Finally the $L1$ sum is calculated for all the propagated and received deformations. Each of these deformations is generated by a unique luminous point. A unique deformation $dI1$ received is such as $dI1^2 = k d^2V$ where k is a constant and d^2V the vacuum propagated with the space-time deformation. In the same way for $L2$, except that this time the deformations come from the opposite sense of propagation (on the same axis).

Let us study the overall result of all the propagated deformations which are received in the same M point at the same time.

The postulate 3 above express the length ratio along Ox axis only. But at one M point there are numerous such directions coming to. Hence it is necessary to calculate the relativistic operator of postulate 3 for each space

direction. The final deformation is then obtained. The only question is: “what is the mode of contribution of the deformations of all these directions in order to obtain the result ?” This result will be the resulting space-time deformation at M point. It will be thus necessary to generalize the above operator with a second more generic operator, which will take into account each space directions. The result given by this second generalized operator must be the famous final space-time deformation at M point. It will be probably useful to use a mathematical base like the quaternions for that. In this article this complexity will not be seen because fortunately not necessary.

We thus found relativity starting from postulates 1, 2, and 3. The α angle of the postulate 1 rotation is calculated, by applying postulates 2 and 3. Overall, we obtained a way for calculating space shape inside space-time.

We can now study Newton's law.

5. FIRST MODIFICATION OF NEWTON'S LAW

The studied case is a particle of mass M isolated in a space filled uniformly with an energy density constant and weak in front of M . The particle coordinates are $x = y = z = 0$ which are those of the O point in our usual inertial frame R of reference. The studied case being invariant by any rotation of center O , only the Ox axis with $x > 0$, and the axis of time Ox , are important.

How does evolve the local slope $\tan(\alpha)$ of space, along Ox axis ?

The postulate 3 above is applied. Let us consider a space-time P point in which comes at least one deformation from a luminous point pertaining to the M mass. We suppose P x -coordinate positive strict that is: $x > 0$.

The M mass propagates on P point the following deformations:

$$\begin{aligned} L1_m &= g(x) && \text{An attenuation function which will be given further.} && (4) \\ L2_m &= 0 && \text{Propagation in the direction of } x \text{ increasing.} \\ &&& \text{No deformation propagated in the direction of } x \text{ decreasing,} \\ &&& \text{coming from } M, \text{ because } x > 0. \end{aligned}$$

The surrounding universe with constant energy density propagates on P point the following deformations:

$$\begin{aligned} L1_u &&& \text{Propagation in the direction of } x \text{ increasing.} && (5) \\ L2_u &= L1_u = L_u && \text{Same thing in the direction of } x \text{ decreasing because space time} \\ &&& \text{is supposed isotropic.} \end{aligned}$$

Hence:

$$\begin{aligned} L1 &= L1_u + L1_m = L_u + g(x) \\ L2 &= L2_u + L2_m = L_u \end{aligned}$$

Now application of postulate 3 is possible:

$$\frac{dx}{ds} = \text{oper}(L_u + g(x), L_u)$$

Let us calculate:

$$\begin{aligned} \frac{dx}{ds} &= \frac{2\sqrt{(L_u + g(x)) L_u}}{L_u + g(x) + L_u} \\ &= \frac{\sqrt{1 + \frac{g(x)}{L_u}}}{1 + \frac{g(x)}{2L_u}} \end{aligned}$$

Let us write:

$$e = \frac{g(x)}{L_u} \quad (6)$$

$$\frac{dx}{ds} = \frac{\sqrt{1+e}}{1+\frac{e}{2}} \quad (7)$$

Approximation: x great, thus $g(x)$ low in front of Lu . Therefore $e \ll 1$. After a limited development of e at order 2:

$$\frac{dx}{ds} \approx 1 - \frac{e^2}{8}$$

Which makes finally, using equation (6):

$$\cos(\alpha) = \frac{dx}{ds} \cong 1 - \frac{g(x)^2}{8L_u^2} \quad (8)$$

Where α is the angle between: **1**) the tangent to the required curve of space in space time : $ct = f(x)$, and **2**) the Ox axis. This curve is the searched space curve.

In addition let's apply the formula of the expression of a force, to an m mass moving.

The relativistic equation is the following one:

$$F = \frac{mv \frac{dv}{dx}}{\left(1 - \frac{v^2}{c^2}\right)^{3/2}}$$

Now let us take the case of a particle with a negligible mass at rest. It is with this particular case that is applied the principle of general relativity: the trajectory of this particle will follow a space-time geodesic. Moreover, if we suppose the particle located infinitely far at $t=0$, then we have, for any x , $v = c \tan(\alpha)$. From where:

$$F = mc^2 \frac{d \tan(\alpha)}{dx} \frac{\tan(\alpha)}{(1 - \tan^2(\alpha))^{3/2}} \quad (9)$$

With $\tan(\alpha) = v/c$. Otherwise, we can write:

$$\begin{aligned} \tan(\alpha)^2 &= \frac{1}{\cos(\alpha)^2} - 1 \\ &\cong \frac{1}{(1 - g(x)^2/(8Lu^2))^2} - 1 && \text{using equation (8)} \\ &\cong \frac{(1 + g(x)^2/(4Lu^2))}{g(x)^2/(4Lu^2)} - 1 \\ \tan(\alpha) &\cong \frac{g(x)}{2Lu} \end{aligned} \quad (10)$$

In addition the required Newton's equation is:

$$F = - mc^2 \frac{R}{x^2} \quad (11)$$

Written with $R = MG/c^2$, the Schwarzschild ray. G is universal gravitation constant.

Let us identify equations (9) and (11):

$$\begin{aligned} m c^2 \frac{d}{dx} [\tan(\alpha)] \tan(\alpha) (1 - \tan(\alpha)^2)^{-3/2} &= - m c^2 R / x^2 \\ \frac{d}{dx} (g(x)) \frac{g(x)}{(1 - v^2/c^2)^{-3/2}} &= - 4 Lu^2 R / x^2 && \text{using equation (10)} \\ \frac{d(g(x))}{dx} \frac{g(x)}{4Lu} &\cong - 4 Lu^2 R / x^2 \end{aligned} \quad (12)$$

Because for x large, and a particle at rest when infinitely far, there is $v \ll c$.

Therefore, for x large, the solution of the differential equation (12) is the following:

$$g(x) = L_u \sqrt{\frac{8R}{x}} \quad (13)$$

This equation can be justified from a physical point of view, using the model of this document, and conservation of space-time propagated vacuum. However, in this document, the possible justifications of this assumption will be left off, and only its consequences will be studied.

We will now postulate that this equation (13) is correct not only for long distances but for any values of x . Therefore, now we can modify equation (9), with the help of equation (10), and the help of equation (13), which is now supposed always correct. Let us remind:

$$\begin{aligned} dx/ds &= \sqrt{[1 + e] / (1 + e/2)} && \text{(equation (7))} \\ &= \cos(\alpha) && \text{because } \alpha \text{ is the angle between the tangent to} \\ &&& \text{the required curve, and Ox axis.} \\ \tan(\alpha)^2 &= 1/\cos(\alpha)^2 - 1 && \text{trigonometric equation.} \\ &= (1 + e/2)^2/(1 + e) - 1 && \text{using equation of } \cos(\alpha) \text{ just above.} \\ \tan(\alpha) &= \sqrt{[(1 + e/2)^2/(1 + e) - 1]} && (14) \end{aligned}$$

$$\text{with } e = \sqrt{[8R/x]} \quad \text{according to (6) and (13).} \quad (15)$$

The equation (9) thus becomes, using (14):

$$F = mc^2 d/dx \{ \sqrt{[(1 + e/2)^2/(1 + e) - 1]} \sqrt{[(1 + e/2)^2/(1 + e) - 1]} (1 - v^2/c^2)^{-3/2} \}$$

From where finally by using the equation (15), and writing $p = \sqrt{[8R]}$:

$$F = mc^2 d/dx \{ \sqrt{[(1 + \frac{1}{2} p/\sqrt{x})^2/(1 + p/\sqrt{x}) - 1]} \sqrt{[(1 + \frac{1}{2} p/\sqrt{x})^2/(1 + p/\sqrt{x}) - 1]} \{ 2 - (1 + \frac{1}{2} p/\sqrt{x})^2/(1 + p/\sqrt{x}) \}^{-3/2} \}$$

After calculations carried out on appendix 2, equation (B):

$$F = - \frac{mc^2 R}{x^2} \frac{1 + \sqrt{\frac{2R}{x}}}{\sqrt{1 + \sqrt{\frac{8R}{x}}} \left(1 + \sqrt{\frac{8R}{x}} - \frac{2R}{x} \right)^{3/2}} \quad (16)$$

This equation (16) is an exact equation, and is not approximated for long distances. After a limited development of e until order 2, carried out on appendix 2, we get:

$$F \approx - \frac{mc^2 R}{x^2} \left(1 - 3\sqrt{\frac{2R}{x}} + \frac{19R}{x} \right) \quad (17)$$

Of course, Newton's equation is retrieved for the particular case of long distances:

$$F_0 = - \frac{mc^2 R}{x^2}$$

However, there is the addition of an $x(-5/2)$ term for the other cases:

$$F \approx F_0 + 3\sqrt{2} mc^2 \frac{R^{3/2}}{x^{5/2}}$$

The gravitational force is weaker than the Newton's force, for small distances.

However, this does not explain the mystery of velocity curve for the stars in the galaxies.
In fact, this correction appears for relativistic values only (v close to c).

6. STAR SPEED MYSTERY

In order to obtain the explanation of the stars speed in a galaxy it is necessary to take into account these stars masses.

For this, the P point is supposed located in the middle of these stars i.e. inside the studied galaxy. We use the same model as above, but now M is the galactic center mass, and x is the distance from the galactic center.

We will approximate that the deformation propagated by these stars and received in P is roughly proportional to the matter density of surrounding stars around P.

We will suppose that this density of matter in a galaxy evolves following an $1/x^2$ law. Confrontation with experimental values, rather than this $1/x^2$ law, will be done later on, in appendix 6 and in [6].

It is possible to add this additional term to L1u (see equation (5)). The surrounding stars propagate on P the following deformations:

$$L1_s = L2_s = \frac{q}{x}$$

Where q is a constant

Hence, a matter density following an $1/x^2$ rule implies that the corresponding symmetric contribution $L1_s = g(y)$ follows an $1/x$ rule. (y is the distance between P and a studied star, g is the function of equation (13)).

That is because we now suppose, as a postulate, the value of each luminous point contribution, $g(x, y)$, having the form: $g(x, y) = \sqrt{[8R/y]} = \sqrt{[8MG/(c^2y)]} = k \sqrt{[8(1/x^2)G/(c^2y)]}$. (k is a constant). This is equation (13) above. Hence we obtain the factor \sqrt{M} and then $\sqrt{[1/x^2]} = 1/x$.

The expressions of the quantities of deformations L1 and L2 received in the P point become:

$$L1 = L1_u + L1_m + L1_s = L_u + g(x) + \frac{q}{x}$$

$$L2 = L2_u + L2_m + L2_s = L_u + 0 + \frac{q}{x}$$

It is cleaner to write that in a homogeneous way, using the result of the preceding study:

$$L1 = L_u \left(1 + \frac{r}{x} + \sqrt{\frac{8R}{x}} \right)$$

$$L2 = L_u \left(1 + \frac{r}{x} \right)$$

r is the “ray” from which the gravitational effect of surrounding stars is noticed.

The equation (15), giving e, changes in the following way.

$$e = \frac{\sqrt{\frac{8R}{x}}}{1 + \frac{r}{x}} \quad \begin{array}{l} \text{received “asymmetrical” propagations} \\ \text{received “symmetrical” propagations} \end{array} \quad (18)$$

The other equations remain unchanged:

$$\cos(\alpha) = \operatorname{oper}(L1, L2) = \frac{\sqrt{1 + e}}{1 + \frac{e}{2}}$$

$$F = mc^2 \frac{d \tan(\alpha)}{dx} \frac{\tan(\alpha)}{(1 - \tan^2(\alpha))^{3/2}} \quad (19)$$

$$v = \sqrt{\frac{F x}{m}}$$

The last equation above explains the centrifugal force in the galaxies.

This “new Newton’s law” (expression of F, equation (19)) is complicated. It can be calculated by computer. The last program of appendix 1 carries that out. It can be also calculated, the result is the following, where $s = 1 + f$, and $f = r/x$:

$$F = -\frac{mMG}{x^2} \frac{\left(s + \sqrt{\frac{2R}{x}}\right) \left(s + 2x \frac{ds}{dx}\right)}{\sqrt{s^2 + s\sqrt{\frac{8R}{x}}} \left(s^2 + s\sqrt{\frac{8R}{x}} - \frac{2R}{x}\right)^{3/2}}$$

(Of course, with $s = 1$, equation (16) is retrieved).

The red curve, which follows, represents the evolution of the calculated speed v.

We suppose $r = 1$ kpc. This value has been adjusted in order to obtain the best possible red curve. The Milky Way value is used for the galactic center mass.

The red curve represents the speed of a star in this supposed galaxy. This star is located between 1 and 15 kpc ($\approx 10^{19}$ m and $4 \cdot 10^{20}$ m) from the galactic center. X-coordinate represents this distance between the star and the galactic center (minus 1kpc = $3 \cdot 10^9$ m; that is to say that the value $x=0$ corresponds to a distance of 1 kpc between the star and the galactic center). The unit used for x is the meter. The ordinate, y, represents the speed, in m/s.

The blue curve represents the speed resulting from traditional Newton’s law.

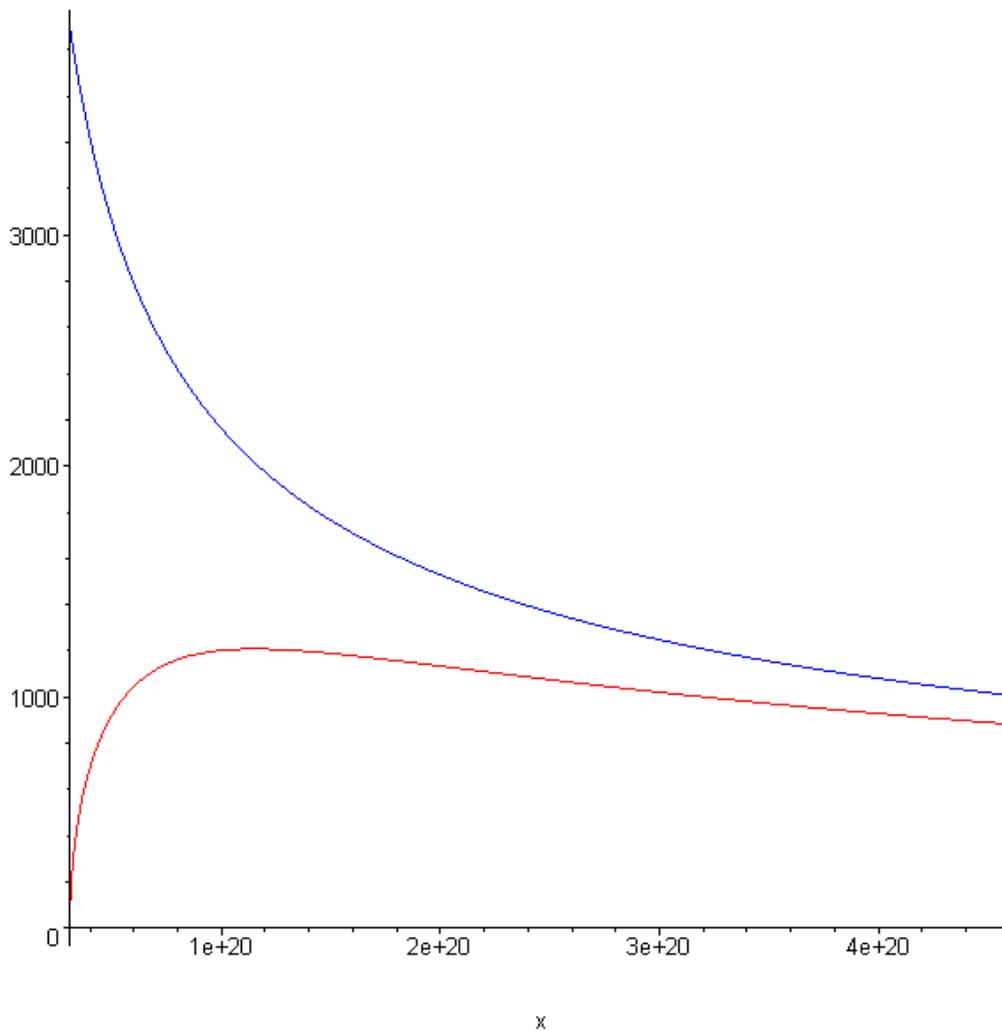


Figure 4: Theoretical curves of the speed of the stars in the galaxy, taking in account their masses.

The variation of the speed of stars in a galaxy is explained.

In any case the explanation is good for distances x in the Milky Way ranging between 3 and 15 kpc (see on the figure between 10^{20} and 4×10^{20} meters).

The figure 4 is false quantitatively. Indeed, the maximum speed indicated for stars is approximately 1000 m/sec. However, measured speeds are actually of 220 km/sec for the Milky Way, which is 220 times greater. That's because is necessary to use the measured evolution of the density of matter. Refer to appendix 6, and [6], for confrontation with experimental values, with other galaxies.

For distances higher than 15 kpc, the two curves fit exactly each other (this is visible on figure 4 but much more visible with another plot in the program. For this, use the program in appendix 1 with other boundaries for plotting, in order to see clearly this fitting of the two curves).

This recalls that, out of the vicinity of the stars, this correction of Newton's law has no effect.

Conversely, this effect takes place in the galaxies because of the presence of a strong density of surrounding matter, inside the galaxies. This great surrounding matter density is coming from the stars of the galaxy. As we have seen, this is adding a third term for the calculation of the relativistic operator which drives space-time shape. For this last reason, this Newton's law correction explains the weak variation of speeds of stars in a galaxy.

Finally, for distances lower than 3 kpc, the theoretical curve obtained is of the same type as the measured one. Our correction of Newton's law explains "solid" nature of galactic center. Refer to appendix 1 for more precise details about figure 4.

7. GALAXY SPEED MYSTERY

Let us study now the case of galaxy groups. We suppose that they are moving around each other, like in the Coma or Virgo galaxy groups.

Hence we start from the classical Newton's law model of chapter 5: the M mass, now representing a galaxy, and the surrounding matter modelled by a uniform density of matter.

Therefore, the equations stay unchanged. Let us remind them:

$$\begin{aligned}
 dx/ds &= \sqrt{[1 + e] / (1 + e/2)} && \text{with } e = L1/L2 - 1 \\
 &\cong 1 - e^2/8 && \text{as seen above} \\
 dx/ds &= \cos(\alpha) \\
 &= 1 / \sqrt{[1 + \tan^2(\alpha)]} \\
 &\cong 1 - 1/2 \tan^2(\alpha) \\
 \tan(\alpha) &\cong e/2 && \text{comes from just above} \\
 F &= mc^2 d/dx(\tan(\alpha)) \tan(\alpha) (1 - \tan(\alpha)^2)^{-3/2} \\
 &\cong mc^2/4 e de/dx (1 - \tan(\alpha)^2)^{-3/2} && \text{using } \tan(\alpha) \text{ above} \\
 &\cong mc^2/4 e de/dx && \text{for long distances}
 \end{aligned}$$

Hence \underline{F} is, very roughly, proportional to:

$$e^2 = \left(\frac{L1 - L2}{L2} \right)^2 = \left(\frac{\text{asymmetric contributions}}{\text{symmetric contributions}} \right)^2$$

Here the asymmetric contributions come from the M mass. The symmetric contributions come from the outer space only.

However, in the case of our old Newton's law, this is different:

- asymmetric contributions are seen the same way (coming from the sun).
- But symmetric contributions are much greater. That is because they come not only from outer space, but also from the Milky Way itself.

As a conclusion, for equal asymmetric contributions, symmetric contributions are much greater inside the Milky Way than outside any galaxy.

Therefore, the gravitational force, and with it, the G constant itself, is much greater, outside any galaxy, than, like us, inside the Milky Way.

Another way to conduct this study is to calculate the G constant. This is done on appendix 4, and gives the following result.

$$G = \frac{c^2}{8\rho_u d^2 \left(\sum_{n=1}^{E(cT/d)} \frac{1}{\sqrt{n}} \right)^2}$$

This formula may be written in a more generic way:

$$G = \frac{c^4}{\left(\sum_p \sqrt{\frac{8e_p}{x_p}} \right)^2} \quad (20)$$

Obtained the same way as in appendix 4.

In this $\ll \sum \gg$ sum above, we do not take into account the luminous points pertaining to the M and m masses which are concerned by Newton's law itself ($F = -GMm/x^2$).

This sum is done for each luminous point, p, along an infinite half-line. This half-line is centered on the location in which we want to calculate G. That is to say that we take into account each luminous points in the universe, except those of the interacting masses for Newton's law.

e_p is the energy of each luminous point.

x_p is the distance of each luminous point from the location in which we calculate G.

On equation (20), G is inversely proportional to $(\sum \sqrt{[8e_p / x_p]})^2$. This value differs greatly from the cases inside, and, outside the Milky Way.

Let us note also:

$$S_i = \sum_p \sqrt{\frac{8e_p}{x_p}} \quad \text{for the luminous points } \textit{inside} \text{ the Milky Way}$$

$$S_o = \sum_p \sqrt{\frac{8e_p}{x_p}} \quad \text{for the luminous points } \textit{outside} \text{ the Milky Way}$$

Then for our case, inside the Milky Way, we can write:

$$\sum_p \sqrt{\frac{8e_p}{x_p}} = S_i + S_o \quad (21)$$

Now for the studied case, which is *outside* any galaxy, we can write:

$$\sum_p \sqrt{\frac{8e_p}{x_p}} = S_o \quad (22)$$

If we note G' the G constant located outside any galaxy, then we have:

$$\frac{G'}{G} = \frac{(S_i + S_o)^2}{S_o^2} = \left(1 + \frac{S_i}{S_o}\right)^2$$

Coming from equations (20), (21), and (22).

For an example, if we need 10 more mass in order to explain the measured galaxies speeds, (this factor 10 was measured for some galaxy group), then we deduce from our explanation: $G'/G = 10$, and then $S_i/S_o = 2,1$.

As an intermediate conclusion, this modelling of relativity might explain the "dark matter" mystery for the velocity of the galaxies inside a heap of galaxies. This explanation is based on a great increase of the G constant in such cases.

Also, this explanation is the same for the mystery of light beam deviation in the vicinity of a galaxy.

8. CONCLUSION

As a conclusion, this new modelling of space-time retrieves general and restricted relativity. Nevertheless, it is more than a simple Euclidean version of relativity, as shown by postulate 1 and 2. Postulate 1 is enough to explain the Sagnac effect in a very simple way.

It is enough to add a 3rd postulate in order to explain “dark matter mysteries”, which are:

- star’s speed inside galaxies, explained by our Newton’s law correction,
- speed of the galaxies themselves, inside their group, and deformation of light trajectories in the vicinity of a galaxy.

Overall, this third postulate conducts a modification of Newton’s law.

This modification is conceived in order to find exactly Newton’s law in the specific case of pin pointed masses and long distances. It uses the usual modelling of Newton’s law, with two specific masses concerned, a gravitational mass M , and an attracted mass m . It finds by construction the law of Newton, for long distances between m and M . However, a correction of Newton’s law is seen in the case of short distances. This first correction occurs in fact for relativistic speeds (speed v of the m mass close to c).

Nevertheless, the important result of this correction of Newton’s law occurs when the galaxy’s stars are introduced in the model.

After this, a strong difference appears between the calculated force and Newton’s law. The curve of the speed of stars in the galaxies, obtained with this corrected Newton’s law, is very close to experimental measurements. This theoretical curved similarity with measured one remains even valid for the “solid” part of the galaxy (i.e. nearest to the galactic center, in which measured speeds are almost proportional to their distance to the center).

That is for “stars speed dark matter” mystery.

For the other “dark matter” mystery, which concerns the case of galaxy groups, the explanation is more direct. This is explained by a different value of G , between our case inside the Milky Way, and the case outside any galaxy. Here again, the “third speaker”, which decrease the G constant, is the stars of our galaxy.

That is for the practical results yielded by this modelling. Moreover, and from a theoretical point of view, this study finds a way for space-time determination. At any point in space-time, this determination is based on the matter density distribution through the whole universe.

It remains also to check if the model described in this article is coherent with other actual physics theories (electromagnetism, quantum mechanics, etc).

As an answer to this last question one will notice that this model is in conformity with [5].

9. APPENDIX

APPENDIX 1 COMPARISON BETWEEN NEWTON'S LAWS

1) Speed of stars in a galaxy, WITHOUT taking into account the stars

This curve is shown on figure 5. In blue is the law of Newton. In red is the law of Newton corrected *without* taking into account of the effect of stars.

The formula $v = \sqrt{[Fx/m]}$, where F is the gravitational force, is used.

The m mass is left in the programs equations below only for comprehension, since in fact it is always simplified.

X-coordinate (in meters) is the distance which separates the star from the center of the galaxy (minus R). The y ordinate represents the speed v (in m/s) of the star in its movement around the galactic center.

The distances lie between R (Schwarzschild's ray) and 40 R. They are thus weak compared to the total size of the galaxy. A difference appears however between the two curves. On the other hand, this difference becomes unimportant for distances ranging between 1 and 15 kpc.

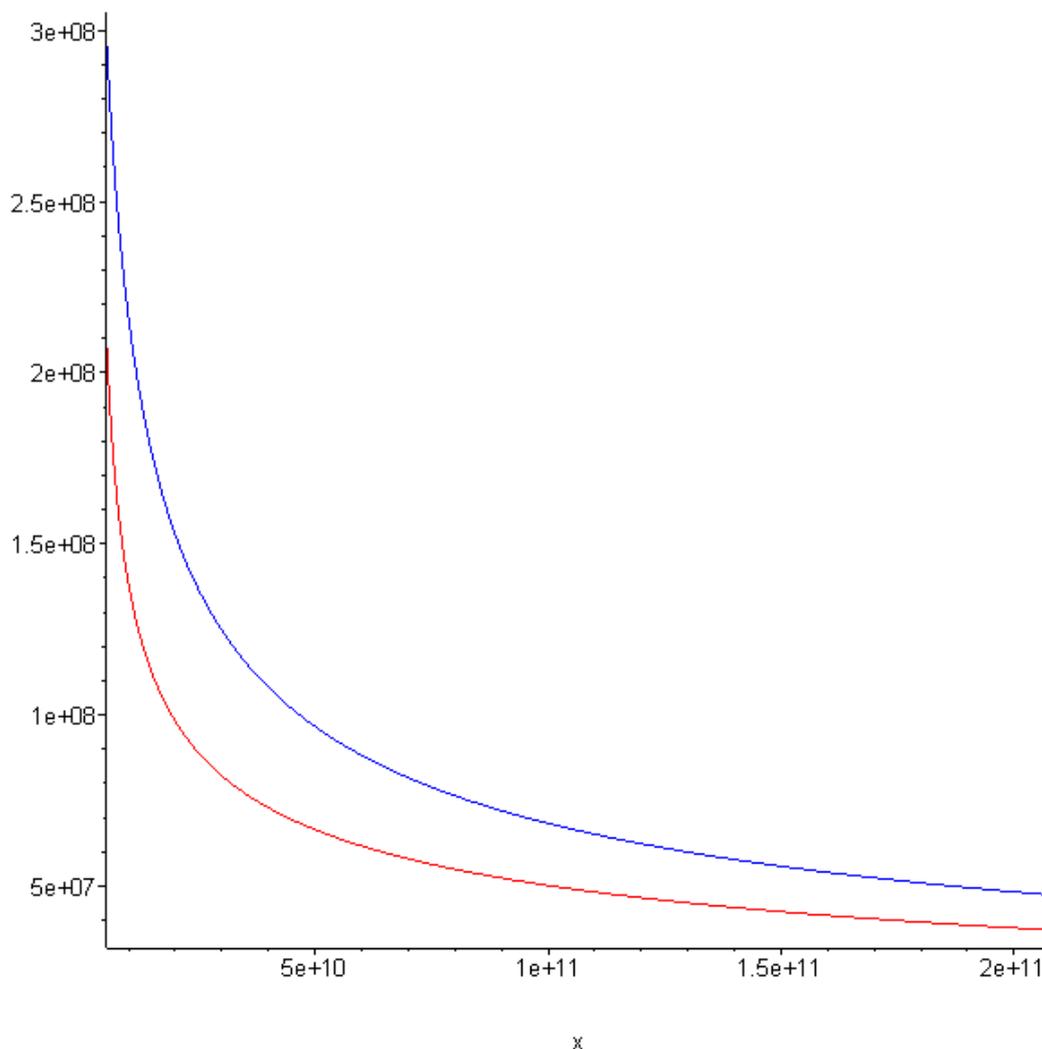


Figure 5: Theoretical curves of the speed of the stars in the galaxy, without taking in account their masses.

Program MAPPLE having posted this figure:

Digits:= 20; m:=1; M:= 7 * 10**36 ; G:= 6.6742867 * 10**(-11); c:= 3 * 10**8;

```

R:= M*G/c**2; # Initialisations.
e:= sqrt(8*R/x); # Famous "relativistic coefficient".
cos2:= (1 + e) / ((1 + e/2)**2); # Square of the relativistic operator.
tg:= sqrt( 1/cos2 - 1 ); # Slope of space inside space-time.
F:= - m * c**2 * diff(tg,x) * tg * (1 - tg**2)**(-3/2); # Our "Newton's law".
FN:= m * c**2 * R / x**2; # Classical "Newton's law".
v:= sqrt( F * x / m ); # Centrifugal force and tangential speed v.
vn:= sqrt( FN * x / m ); # The same for classical Newton's law.
plot([v(x), vn(x)], x=R..40*R, color=[red,blue], style=[line,line], numpoints=1000); # Plotting the 2 curves from R to 40 R.

```

2) Speed of stars in a galaxy, TAKING into account the stars

This curve has been shown on figure 4. In blue is Newton's law. In red is our corrected Newton's law, corrected *taking* into account the effect of the stars.

The program uses the formula $v = \sqrt{[Fx/m]}$, where F is the gravitational force. It uses also $r = 1$ kpc. This value was adjusted in order to obtain the best possible red curve.

X-coordinate (in meters) is the distance which separates the star from the center of the galaxy. The y ordinate (in m/s) represents the speed v of the star in its movement around the center of the galaxy.

The distances considered lies between 1 and 15 kpc, they are those of the stars in the Milky Way. This time the difference between the two curves is very clear.

Program MAPPLE having posted this figure:

```

unassign('x'); Digits:= 30: m:=1: M:= 7 * 10**36: G:= 6.6742867 * 10**(-11): c:= 3 * 10**8:
R:= M*G/c**2: kpc:= 3.08 * 10**19: # Initialisations.
r:= 1 * kpc: # Value fitted progressively in order to obtain the best possible red curve.
e:= sqrt(8*R/x) / (1 + r/x): # Famous "relativistic coefficient".
cos2:= (1 + e) / ((1 + e/2)**2): # Square of the relativistic operator.
tg:= sqrt( 1/cos2 - 1 ): # Slope of space inside space-time.
F:= - m * c**2 * diff(tg,x) * tg * (1 - tg**2)**(-3/2): # Our "Newton's law".
FN:= m * c**2 * R/(x**2): # Classical "Newton's law".
v:= sqrt( F * x / m ): # Centrifugal force and tangential speed v.
vn:= sqrt( FN * x / m ): # The same for classical Newton's law.
x := y*kpc:
plot([v,vn], y=1..15, color=[red,blue], style=[line,line], numpoints=1000, title="Speed profiles", legend=["three elements",
"Newton'law"], labels=["Distance from the galactic center in kpc", "Speed in km/sec"]);
# Plotting from 1 to 15 kpc.

```

3) Comparison with the measured speed of the stars of the galaxies

See figure 7 below. The shape of the red curve of figure 6 is similar to the one below.

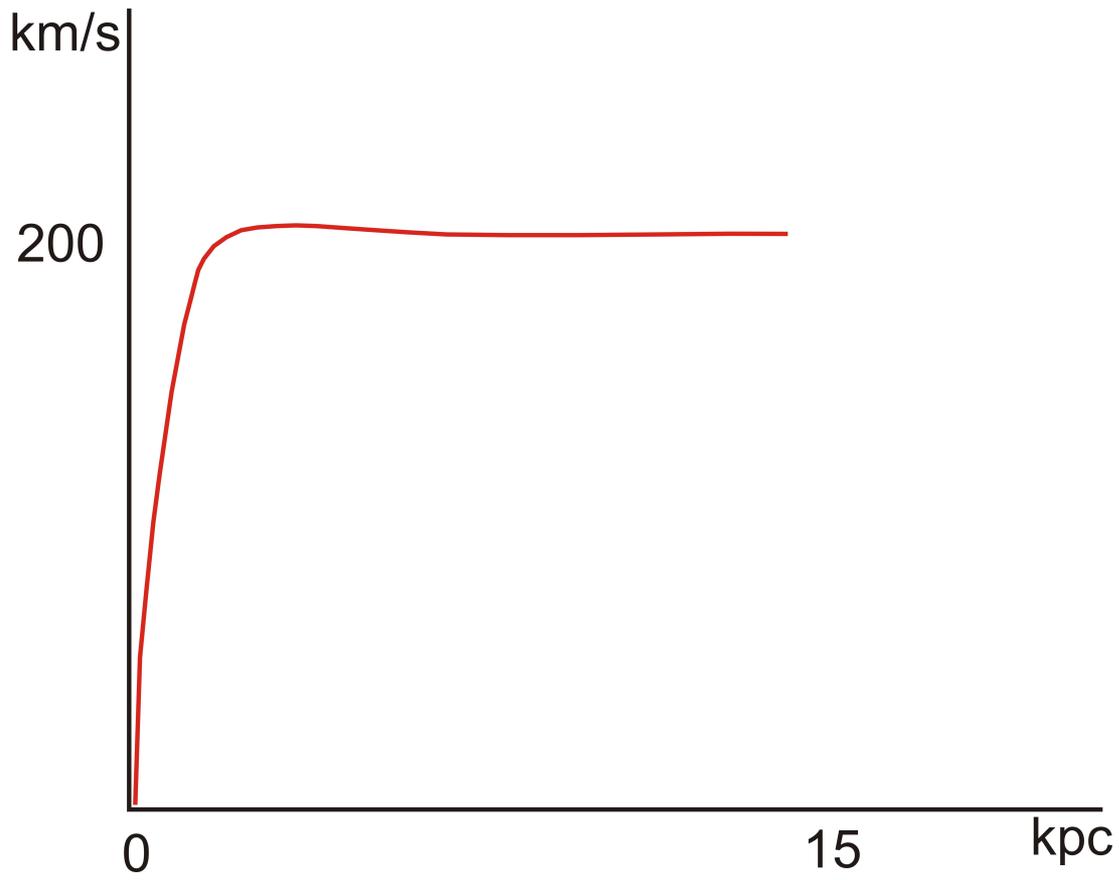


Figure 6: Curve of the measured speed of stars in a galaxy.

APPENDIX 2 FIRST NEWTON'S LAW CORRECTION

This appendix contains the calculations used to retrieve the first correction of Newton's law of chapter 5 (the case of a planetary system).

$$F = mc^2 \frac{d}{dx} \left\{ \sqrt{\left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]} \sqrt{\left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]} \right\} \left\{ 2 - \left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) \right\}^{-3/2}$$

1) Calculation of derived formula:

$$\begin{aligned} \frac{d}{dx} \left\{ \sqrt{\left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]} \right\} \\ &= \frac{1}{2} \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]^{-1/2} (f'g - fg')/g^2 \\ &= \frac{1}{2} \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]^{-1/2} (f'g - fg')/g^2 \end{aligned}$$

$$\begin{aligned} f &= \left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 \\ f' &= 2 \left(1 + \frac{1}{2} p/\sqrt{x}\right) p/2 (-1/2) x^{-3/2} \\ &= -p/2 \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} \\ g &= \left(1 + p/\sqrt{x}\right) \\ g' &= p (-1/2) x^{-3/2} \\ &= -p/2 x^{-3/2} \end{aligned}$$

$$\begin{aligned} (f'g - fg')/g^2 &= \left[-p/2 \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} \left(1 + p/\sqrt{x}\right) - \left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 (-p/2) x^{-3/2} \right] \\ &= \frac{(p/2) \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} \left[-\left(1 + p/\sqrt{x}\right) + \left(1 + \frac{1}{2} p/\sqrt{x}\right) \right]}{\left(1 + p/\sqrt{x}\right)^2} \\ &= \frac{(p/2) \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} (-1/2) p/\sqrt{x}}{\left(1 + p/\sqrt{x}\right)^2} \\ &= -\frac{(p/4) \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} p}{\sqrt{x} \left(1 + p/\sqrt{x}\right)^2} \\ &= -\frac{(p^2/4) \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2}}{\left[\left(1 + p/\sqrt{x}\right)^2 \sqrt{x} \right]} \end{aligned}$$

$$\begin{aligned} \frac{d}{dx} \left\{ \sqrt{\left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]} \right\} \\ &= \frac{1}{2} \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]^{-1/2} \left[-\frac{(p^2/4) \left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2}}{\left[\left(1 + p/\sqrt{x}\right)^2 \sqrt{x} \right]} \right] \\ &= -\frac{(p^2/8) \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]^{-1/2} \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} \right]}{\left[\left(1 + p/\sqrt{x}\right)^2 \sqrt{x} \right]} \end{aligned}$$

$$F = -mc^2 p^2/8 \left\{ \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]^{-1/2} \left[\left(1 + \frac{1}{2} p/\sqrt{x}\right) x^{-3/2} \right] \right\} \left\{ \sqrt{\left[\left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) - 1 \right]} \left\{ 2 - \left(1 + \frac{1}{2} p/\sqrt{x}\right)^2 / (1 + p/\sqrt{x}) \right\}^{-3/2} \right\}$$

2) Simplification:

Let's us say: $e = p/\sqrt{x}$. Then:

$$F = -m c^2 p^2/8 \sqrt{x} \left[\left(1 + \frac{1}{2} e\right)^2 (1 + e)(-1) - 1 \right]^{-1/2} \left(1 + \frac{1}{2} e\right) x^{-3/2} \left((1 + e)(-2) \right) \sqrt{\left[\left(1 + \frac{1}{2} e\right)^2 (1 + e)(-1) - 1 \right] \left[2 - \left(1 + \frac{1}{2} e\right)^2 (1 + e)(-1) \right]^{-3/2}}$$

$$F = -m c^2 p^2/8 \sqrt{x} \left(1 + \frac{1}{2} e\right) x^{-3/2} \left((1 + e)(-2) \right) \frac{\text{Great simplification here}}{\left[2 - \left(1 + \frac{1}{2} e\right)^2 (1 + e)(-1) \right]^{-3/2}}$$

$$F = -m c^2 p^2/8 x^2 \left(1 + \frac{1}{2} e\right) \left((1 + e)(-2) \right) \left[2 - \left(1 + \frac{1}{2} e\right)^2 (1 + e)(-1) \right]^{-3/2} \quad \text{(A)}$$

$$F = -mMG/x^2 \frac{1 + \frac{1}{2} e}{(1 + e)^2 \left[2 - \left(1 + \frac{1}{2} e\right)^2 / (1 + e) \right]^{3/2}}$$

$$F = -mMG/x^2 \frac{1 + \frac{1}{2} e}{(1 + e)^2 \left[(2(1+e) - (1 + \frac{1}{2} e)^2) / (1 + e) \right]^{3/2}}$$

$$F = -mMG/x^2 \frac{1 + \frac{1}{2}e}{(1+e)^2 [(2+2e - 1 - e - \frac{1}{4}e^2)/(1+e)]^{3/2}}$$

$$F = -mMG/x^2 \frac{1 + \frac{1}{2}e}{(1+e)^2 [(1+e - \frac{1}{4}e^2)/(1+e)]^{3/2}}$$

$$F = -mMG/x^2 \frac{1 + \frac{1}{2}e}{\sqrt{[1+e]} (1+e - \frac{1}{4}e^2)^{3/2}}$$

With $e = p/\sqrt{x} = 2\sqrt{[2MG]}/c\sqrt{x}$:

$$F = -mMG/x^2 \frac{1 + \sqrt{[2MG]}/c\sqrt{x}}{\sqrt{[1+2\sqrt{[2MG]}/c\sqrt{x}]} (1+2\sqrt{[2MG]}/c\sqrt{x} - \frac{1}{4}(2\sqrt{[2MG]}/(c\sqrt{x}))^2)^{3/2}}$$

$$F = -mMG/x^2 \frac{1 + \sqrt{[2R]}/\sqrt{x}}{\sqrt{[1+2\sqrt{[2R]}/\sqrt{x}]} (1+2\sqrt{[2R]}/\sqrt{x} - 2R/x)^{3/2}} \quad (\mathbf{B})$$

R Schwarzschild length: $R = MG/c^2$.

3) Limited Taylor development:

From (A) equation:

$$\begin{aligned} F &= -mc^2p^2/8x^2 && (1 + \frac{1}{2}e) (1 - 2e + (-2)(-3)/2 e^2) [2 - (1 + e + 1/4 e^2) (1 - e + e^2)] (-3/2) \\ F &= -mc^2p^2/8x^2 && (1 + \frac{1}{2}e) (1 - 2e + 3e^2) [2 - (1 - e + e^2 + e(1 - e + e^2) + 1/4 e^2)] (-3/2) \\ F &= -mc^2p^2/8x^2 && ((1 + \frac{1}{2}e) - 2e(1 + \frac{1}{2}e) + 3e^2) [2 - (1 - e + e^2 + e - e^2 + 1/4 e^2)] (-3/2) \\ F &= -mc^2p^2/8x^2 && (1 - 3/2 e + 2e^2) [1 - 1/4 e^2] (-3/2) \\ F &= -mc^2p^2/8x^2 && (1 - 3/2 e + 2e^2) (1 + 3/8 e^2) \\ F &= -mc^2p^2/8x^2 && (1 + 3/8 e^2 - 3/2 e + 2e^2) \end{aligned}$$

With $e = p/\sqrt{x}$, that is:

$$\begin{aligned} F &= -mc^2p^2/8x^2 && (1 - 3/2 p/\sqrt{x} + 19/8 p^2/x) \\ F &= -mc^2p^2/8x^2 && (1 - (3p/2)/\sqrt{x} + (19p^2/8)/x) \end{aligned}$$

APPENDIX 3 COSMOLOGICAL VALUES

These are the cosmological values, used in this document:

G	=	$6,6742867 \cdot 10^{(-11)} \text{ m}^3 \text{ kg}^{(-1)} \text{ s}^{(-2)}$	universal gravitation constant
1 year light	=	$365 \cdot 24 \cdot 3600 \cdot 3 \cdot 10^{**8} \text{ m}$	
	=	$9.46 \cdot 10^{**15} \text{ m}$	
1 parsec	=	3.26 year-light	
	=	$3.26 \cdot 9.46 \cdot 10^{**15} \text{ m}$	
	=	$30.8 \cdot 10^{**15} \text{ m}$	
	=	$3.08 \cdot 10^{**16} \text{ m}$	
1 kpc	=	1000 parsec	
	=	$3.08 \cdot 10^{**19} \text{ m}$	
M0	=	$2 \cdot 10^{**30} \text{ kg}$	sun mass
M	=	$3.5 \cdot 10^{**6} M0$	mass of the Milky Way center
	=	$7 \cdot 10^{**36} \text{ kg}$	

APPENDIX 4 CALCULATION OF G

The aim of this appendix is to calculate the value of G, the universal constant of gravitation.

We will use Lu, value which has been used in this document (equation (5)).

Lu is representing the contribution of outer space matter, for the calculus of relativistic operator. Let us remind that the relativistic operator allows the determination of space shape, inside space-time, for each point of space.

The Lp contribution of each luminous point, used for the calculation of Lu final value, is given by equation (13) applied in the case of a luminous point:

$$L_p = k \sqrt{[R_p/x]} \quad \text{Where } R_p = m_p G/c^2, \text{ with } m_p = e_p /c^2, \text{ and } e_p \text{ is the energy, supposed constant, here, of each luminous point.}$$

k is a constant whom value is not of great importance, because it will always be simplified later on where calculating relativistic operator.

x is the distance between the luminous point and the P point, P point where this contribution Lp is received.

Lu is the sum of each Lp contribution, for each luminous point along a half-line. This half-line is centered on P point. On this P point we wish to calculate the shape of space in space-time.

That is to say:

$$L_u = k \sum_{\text{On the half-line}} L_p$$

Here we will make important approximations. We will now “forget” the Milky Way in this sum. Because the aim here is to obtain a *formal* simple equation.

Moreover, the sum will be roughly evaluated here: we will consider that matter is regularly distributed to form a grid of luminous points, with a distance of d between each luminous points.

With such hypothesis, the equation of Lu becomes:

$$L_u = k \sum_{n=1}^{E(cT/d)} \sqrt{[R_p / (nd)]} \quad \begin{array}{l} E(x) \text{ is the first decimal number smaller than } x. \\ d \text{ is the mean distance between two luminous points.} \\ T \text{ is the age of the universe.} \end{array}$$

$$= k \sum_{n=1}^{E(cT/d)} \sqrt{[m_p G / (c^2 nd)]} \quad \text{(A)}$$

We also get, if ρ_u is the universe matter density:

$$\rho_u = (1/d)^3 m_p \quad \text{Actual mass in a cubic meter.}$$

Then:

$$m_p = \rho_u d^3 \quad \text{(B)}$$

Then, replacing m_p by this value in equation (A):

$$\begin{aligned} L_u &= k \sum \sqrt{[\rho_u d^2 G / (c^2 n)]} \\ &= k d/c \sqrt{[\rho_u G]} \sum 1/\sqrt{n} \end{aligned} \quad (\text{C})$$

Same way, for an m mass, the Lm contribution is:

$$L_m = k \sqrt{[R/x]} \quad \text{With } R = mG/c^2. \quad (\text{D})$$

Other way, we have, coming from equation (13):

$$L_m = L_u \sqrt{[8R/x]} \quad (\text{E})$$

Then using (D) and (E):

$$k \sqrt{[R/x]} = L_u \sqrt{[8R/x]}$$

That is:

$$k \sqrt{[R/x]} = k d/c \sqrt{[\rho_u G]} \sum 1/\sqrt{n} \sqrt{[8R/x]} \quad \text{Using (C).}$$

This equation is, eliminating k, R and x and using (B):

$$G = \frac{d c^2}{8m_p \left(\sum_{n=1}^{E(cT/d)} \frac{1}{\sqrt{n}} \right)^2} \quad (\text{F})$$

We note that G is proportional with d and inversely proportional with mp.

Matter density in the universe leads the symmetric contributions for relativistic operator.

We have written: $e = L_{\text{asymmetric}} / L_{\text{symmetric}}$.

Therefore, a great symmetric part leads to a weaker e, and then leads to increase the relativistic operator oper(L1, L2), as we saw from equation (7). Conversely, a low asymmetric part leads to decrease it.

Of course the value of this relativistic operator leads directly the value of the attracting force, and leads the value of G. The weaker the relativistic operator dx/ds, the greater the generated force.

Finally, consequently, the more is surrounding universe matter density, the weaker is G.

Let us rewrite G from (B) and (F):

$$G = \frac{c^2}{8\rho_u d^2 \left(\sum_{n=1}^{E(cT/d)} \frac{1}{\sqrt{n}} \right)^2} \quad (\text{G})$$

T	Universe age.
ρ_u	Universe average mean matter density.
d	Universe average mean distance between 2 luminous points.
c	Speed of light.
G	Gravitation universal constant.

APPENDIX 5 INVARIANCE OF THE RELATIVISTIC OPERATOR

1) Aim

The aim of this appendix is to check, directly with calculation, that the final space's shape is the same when calculating in another inertial frame.

That means checking that the choice of the inertial frame, made by postulate 3, has no incidence on its final result. That is to say, also, that the relativistic operator is a space-time invariant through inertial frames. What must be proven exactly is that the value of this operator in a R reference frame, $\text{oper}(L1, L2)$, is always equal to $\sqrt{[1 - v^2/c^2]}$, where v is the speed of the particle inside R.

This invariance is a direct consequence of constancy of speed of light through Lorentz's transformation. Hence, the calculations which are done from figure 3 are always the same whatever R reference frame is used, because the slope of L1 and L2 segments are equal to 1 and -1, respectively. This last property comes from the fact that the speed of light is always the same.

Nevertheless, we will prove this by direct calculation.

2) Modeling

Let's take two inertial frames R (O x y z ct) and R' (O' x' y' z' ct'), like in the construction of classical Lorentz's equations.

We suppose then O' point moving at constant speed v along Ox axis, parallel to O'x' axis, and we suppose O(0,0) in R when and where O'(0,0) in R'.

We use also the same model as the one used in figure 3. We draw L1 and L2 trajectories inside R inertial frame. We must also draw those trajectories in R', this time noted L1' and L2'.

We suppose a P particle at a constant w speed along Ox axis in R, and w' speed compared to R'.

At $t=0$ in R we suppose P particle position at $x=0$.

At t in R we suppose P particle position at x such as $l1 + l2 = ct$ and $l1 - l2 = wt$.

Hence this is figure 3 drawing. We have also a second figure, constructed from figure 3 and replacing L1 trajectory by L1', L2 by L2', and R(O x y z ct) by R' (O' x' y' z' ct').

Also we have the equations of Lorentz's transformation from R to R':

$$x' = \gamma (x - vt) \quad \text{with } \gamma = 1 / \sqrt{[1 - v^2/c^2]} \quad \text{(A)}$$

$$ct' = \gamma (-(v/c)x + ct) \quad \text{(B)}$$

3) From L1 to L1'

At the end of the L1 segment, the (x, ct) coordinates in R are the following: (l1 l1).

In R' those coordinates become (l1', ct1') such as:

$$l1' = \gamma l1 (1 - v/c) \quad \text{using equation (A) with } x = ct = l1 \quad \text{(C)}$$

But also we have:

$$l1 = (ct/2) (1 + w/c) \quad \text{using equation (1) located at the beginning of this document, after replacing } v \text{ by } w \text{ in these equations (particle's speed in R).}$$

Hence, (C) equation is modified :

$$l1' = \gamma ct/2 (1 + w/c) (1 - v/c) \quad \text{(D)}$$

Using (B) equation we retrieve the same value. Hence finally:

$ct_1' = 1l'$ of course, constancy of light speed through Lorentz's transformation

4) From L2 to L2'

The (x, ct) coordinates of the A point, located at the end the L2 segment inside R frame, are: (1l-1l2, 1l+1l2). These coordinates in R' became (x2', ct2') such as:

$$\begin{aligned} x_2' &= \gamma (1l-1l_2 - vt) && \text{using (A) equation} \\ ct_2' &= \gamma [-(v/c)(1l-1l_2) + ct] && \text{using (B) equation} \\ x_2' &= \gamma (w - v) t && \text{using équation (1)} \\ ct_2' &= \gamma ct (1 - vw/c^2) && \text{idem} \end{aligned} \quad \text{(E)}$$

Then we can calculate 1l2':

$$\begin{aligned} 1l_2' &= x_1' - x_2' \\ &= \gamma ct/2 (1 + w/c) (1 - v/c) - \gamma (w - v) t && \text{using (D), (E), and } x_1' = 1l_1' \\ &= \gamma ct/2 (1 + v/c) (1 - w/c) \end{aligned} \quad \text{(F)}$$

The same way:

$$\begin{aligned} 1l_2' &= ct_1' - ct_2' \\ &= \gamma ct/2 (1 + w/c) (1 - v/c) - \gamma ct (1 - vw/c^2) && \text{using now the equation for time,} \\ &= \gamma ct/2 (1 + v/c) (1 - w/c) && \text{this yields of course} \\ &&& \text{the same result.} \end{aligned}$$

5) Calculating the relativist operator in R'

Let's write again the results above:

$$\begin{aligned} 1l_1' &= \gamma ct/2 (1 - v/c) (1 + w/c) \\ 1l_2' &= \gamma ct/2 (1 + v/c) (1 - w/c) \end{aligned}$$

We can now calculate the relativistic operator in R' frame:

$$\begin{aligned} \text{oper}(1l_1', 1l_2') &= \sqrt{[1l_1' 1l_2'] / (1l_1' + 1l_2')/2} \\ &= \frac{\sqrt{[(1 - v/c) (1 + w/c) (1 + v/c) (1 - w/c)]}}{[(1 - v/c) (1 + w/c) + (1 + v/c) (1 - w/c)] / 2} \\ &= \frac{\sqrt{[1 - v^2/c^2]} \sqrt{[1 - w^2/c^2]}}{1 - vw/c^2} \end{aligned} \quad \text{(G)}$$

We must use the relativistic speed composition formula, because we are in the case of two Lorentz's transformations to compose:

$$w = \frac{v + w'}{1 + vw'/c^2}$$

Hence, the (G) equation becomes:

$$\begin{aligned} \text{oper}(1l_1', 1l_2') &= \frac{\sqrt{[1 - v^2/c^2]} \sqrt{[1 - ((v + w')/(1 + vw'/c^2))^2/c^2]}}{1 - [(v + w')/(1 + vw'/c^2)]v/c^2} \\ &= \sqrt{[1 - w'^2/c^2]} \end{aligned}$$

Which is the expected result.

APPENDIX 6 VALIDATION

1) Aim

This appendix validates the solution for dark matter mystery of the actual document. For this, a program is calculating the curve for the star's velocities around the center of the NGC 3310, NGC 1068, NGC 157, NGC 7541, and NGC 7331 galaxies. This program is available in [6], as well as details about this validation.

The result is the following :

- exactly same shape between measured curves and theoretical curves, .
- calculated rotational speeds are very close to measured values: 64 % of precision for NGC 1068, and 9% of precision for NGC 3310).

This calculation is based on corrected Newton's law of chapter 6. It uses experimental data coming from [2,3,4]. More details about this validation are available in [6].

2) Results

NGC 3310

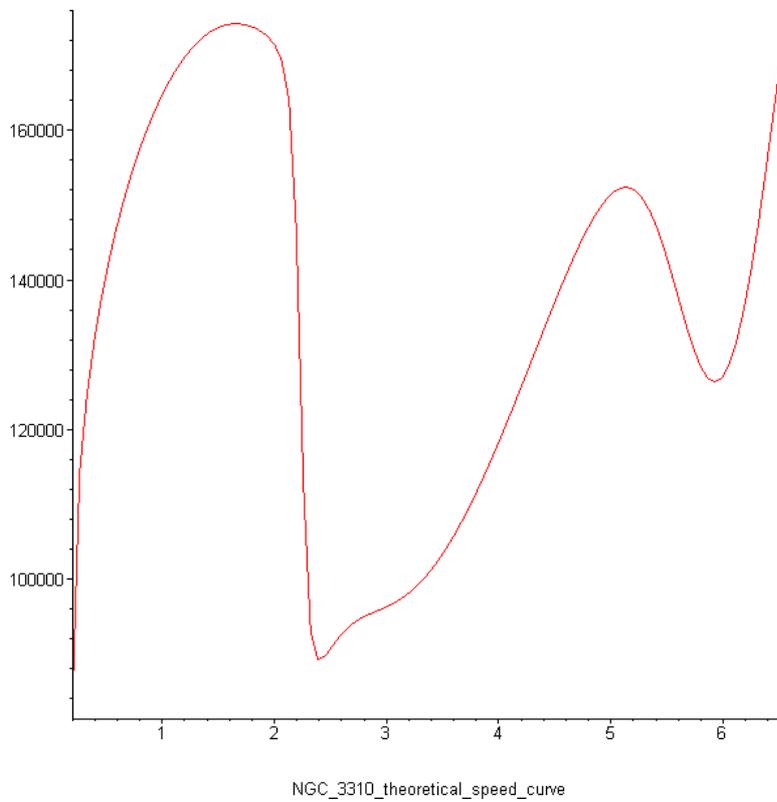


Figure 7: Theoretical speed curve of the NGC 3310 galaxy.

The unit of the x ordinate on the figure above is the kpc. The unit of the y ordinate is m/s.

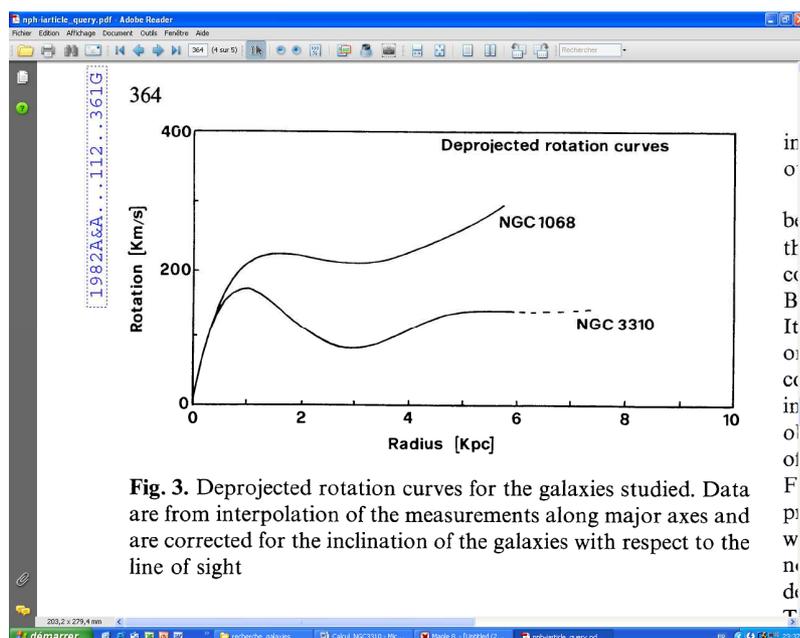


Fig. 3. Deprojected rotation curves for the galaxies studied. Data are from interpolation of the measurements along major axes and are corrected for the inclination of the galaxies with respect to the line of sight

Figure 8: Measured speed curve of the NGC 3310 galaxy.

NGC 1068

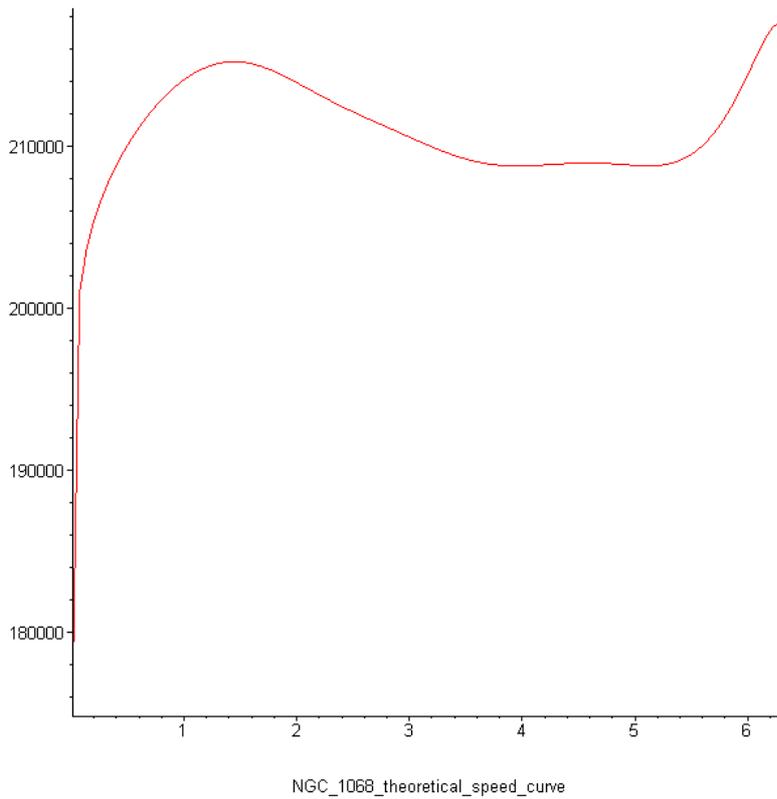


Figure 9: Theoretical speed curve of the NGC 1068 galaxy.

The unit of the x ordinate on the figure above is the kpc. The unit of the y ordinate is m/s.

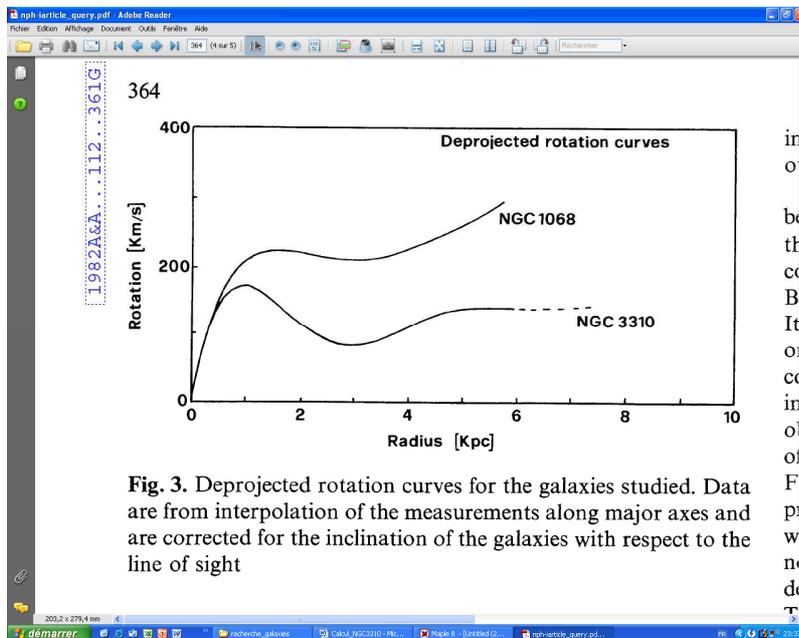


Figure 10: Measured speed curve of the NGC 1068 galaxy.

NGC 157

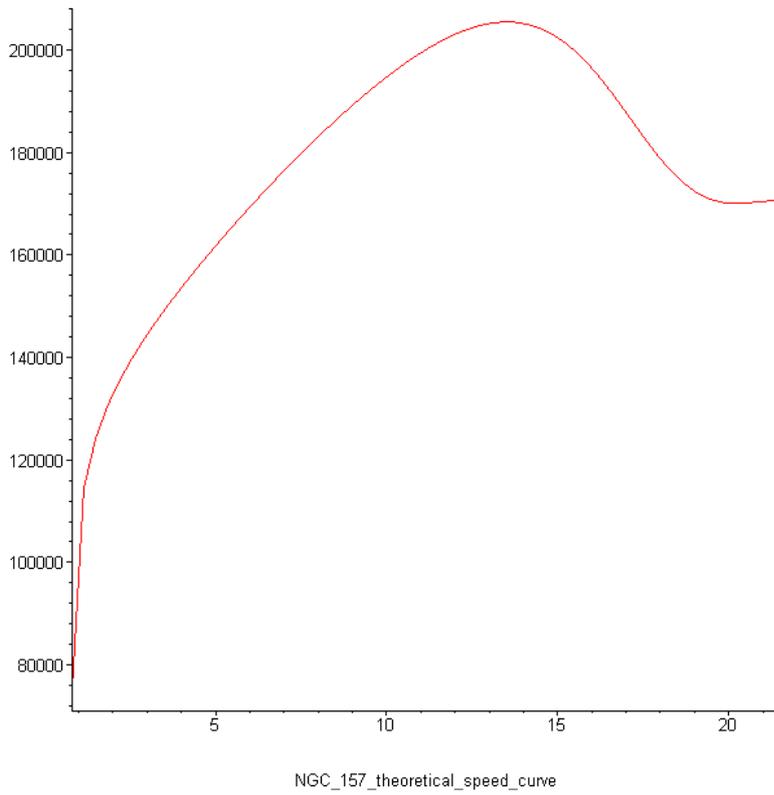


Figure 11: Theoretical speed curve of the NGC 157 galaxy.

The unit of the x ordinate on the figure above is the kpc. The unit of the y ordinate is m/s.

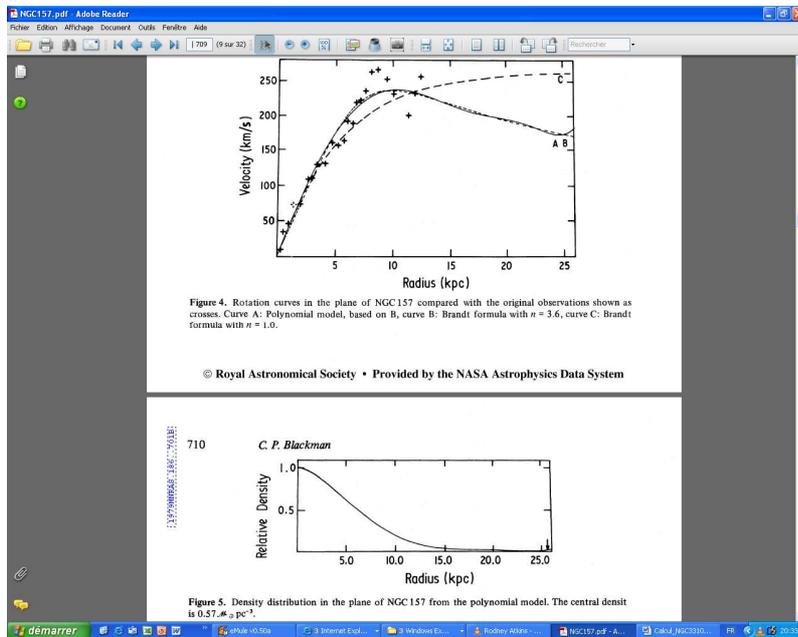


Figure 12: Measured speed curve for NGC 157 (above in plain line).

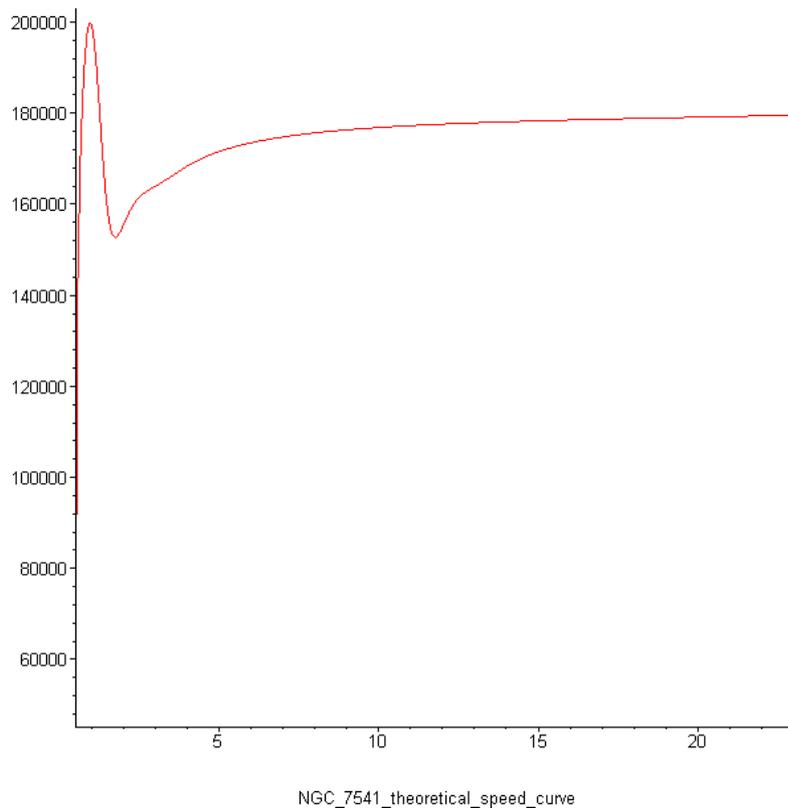
NGC 7541

Figure 13: Theoretical speed curve of the NGC 7541 galaxy.

The unit of the x ordinate on the figure above is the kpc. The unit of the y ordinate is m/s.

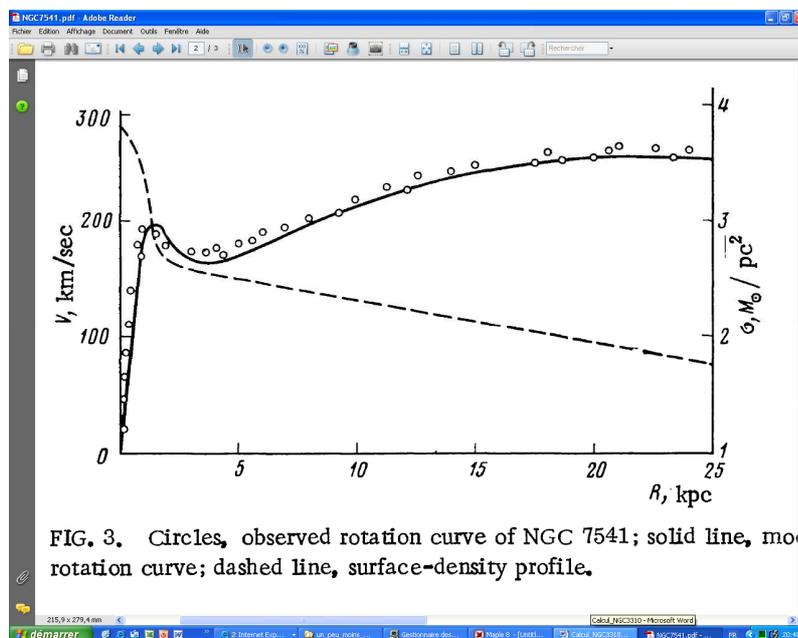


Figure 14: Measured speed curve for NGC 7541.

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